THE NEW MILLENNIUM PROGRAM: TECHNOLOGY FOR EXPLORATION IN THE 21ST CENTURY. Ellen R. Stofan (ellen.r.stofan@jpl. nasa.gov), Caml A. Raymond, Michael R. Gunson, Robert M. Nelson, and Suzanne E. Smrekar, MS 183-501, 4800 Oak Grove Dr., Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109.

During the 20th century, NASA's Earth and space science program has focused primarily on reconnaissance and initial characterization of the Earth and the solar system. Single or dual spacecrafts with complex complements of instruments have gathered fundamental in formation about planetary surfaces, atmospheres, and the interplanetary environment. Observations of the Earth from space have yielded a wealth of dirts which has pushed the research frontier beyond characterization to the study of complex processes. As wc approach the 21st century, the fiscal environment, our technological capabilities, and our relative maturity in terms of understanding the Earth and the solar system all point to a ncw paradigm; one that capitalizes on ncw technologies to enable frequent launches of low mass, low-cost missions addressing focused sets of science questions. The New Millennium Program (NMP) has been developed by NASA to enable this ncw paradigm by flight-demonstrating, in a writs of tcchrlology-driven missions, key technologies to reduce costs and enhance the capabilities of future science missions. While these are technology-rfrivcn, they will also be required to return valuable science data.

The Ncw Millennium Program, managed by the Jet Propulsion Laboratory for NASA, is a joint program between NASA's C) ffices of Space Science (Code S) and Mission to Planet Earth (Code Y). NMP will utilize revolutionary new technologies and architectures, selected from the existing 'technology pipeline' of ongoing technology programs of NASA, other government agencies, industry, nonprofit organizations, and academia. Partnerships arc being formed with these organizations to develop and flight validate breakthrough technologies. The perceived risk in using key enabling technologies will be reduced sufficiently through NMI' validation flights to facilitate rapid incorporation into future Earth and space science missions. These technologies wil I address methods for producing lower mass spacecraft capable of launching on lower cost launch vehicles, and for increasing spacecraft autonomy to reduce operations costs. Advances in microelectronics and microelectrom echanical systems (MEMs) technologies will be employed to make smaller, more capable instruments. Advanced propulsion techniques will be utilized, allowing spacec raft to reach their destinations faster without increasing mass. The flight demonstration of these kcy technologies by NMP will make ready the capabilities needed to enable frequent, affordable and exciting Earth and spree science missions in the 2 1st century.

In order to ensure that NMP will flight validate technologies needed for Earth and space science missions of the future, deficiencies in capabilities precluding the implementation of high priority science missions were identified. The New Millennium Science Working Group, consisting of Earth and space scientists from government and academia, first developed a vision of scientific exploration in the next century. From this vision, they identified kcy capability needs, that could then be translated into areas of needed technology development and validation. Several specific themes emerged from the vision- themes that involve two mission approaches. in the first, a fleet of individual spacecraft is needed to explore many diverse targets among the planets, their satellites, and small bodies in the solar system. The second approach involves coordinated networks of spacecraft to investigate dynamic, complex systems, such as Earth's atmosphere. A "virtual presence" will he established through the combined usc of individual spacecraft, and networks or constellations of spacecraft, The questions raised by our initial reconnaissance of the solar system, combined with our desire to understand how common Earth-like planets arc, require frequent, challenging missions to study the solar system for knowledge and to better understand the potential for llarth-like planets around other stars. Advances in modeling Earth system require increasing spatial anrt temporal resolution and sensitivity, while maintaining lrsug-term calibrations and presenting backward compatibility with current data sets.

To identify the highest priority technologies for flight validation, members of the technology and science communities were asked to propose candidate technology concepts that would address the kcy capabilities derived from the vision for Earth and space science in the 2 1st century described above. Each team maintains a technology roadm - a phased technology development plan needed to achieve the required capabilities. Each team is responsible for identifying the costs associated with advancing each technology to the point where it is ready for validation. The teams also facilitate the final development phases of technologies selected for Ncw Millennium validation flights,

Series of candidate technology validation mission sets arc developed that attempt to maximize the number of technologies validated, while meeting the cost cap of the NM}'. These mission sets arc evaluated on the basis of their technology richness, their contribution to enabling the vision of exploration in the 2 1st century, and their science value. From this evaluation, two candidate deep space technology validation flights and one Earth-orbiting flights have been selected. The first deep space flight (DS - 1) will test advanced propulsion technologies and miniaturized instruments [1]. The second deep space flight (DS-2) is a penetrator piggyback on the Mars 98 mission [2]. The first Earth technology validation mission (EO-1) will validate advanced land imaging technologies. At this time, candidate missions for the next three deep space missions and next Earth orbiting missions are being evaluated. Candidate technologies fur space science include: sample return technologies, free-flying interferometry, deployable structures, aerobots, in situ microinstruments and rovers, autonomous operations, and advanced propulsion capabilities